

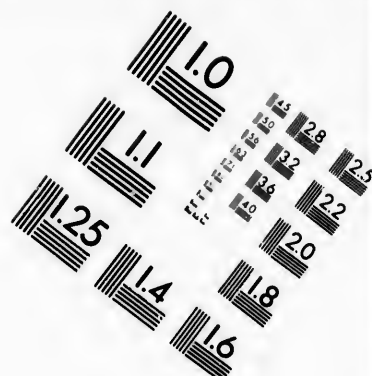
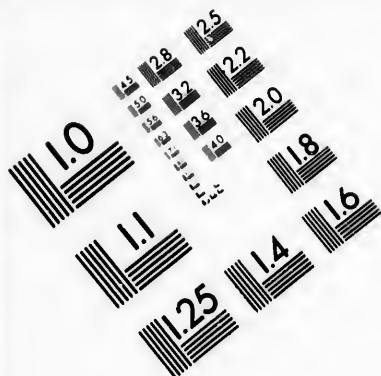
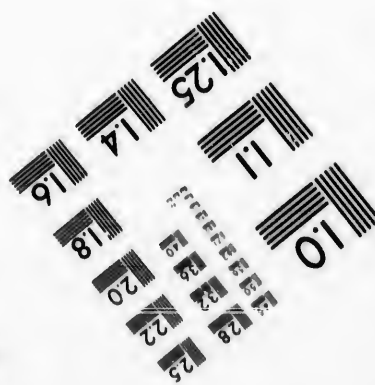
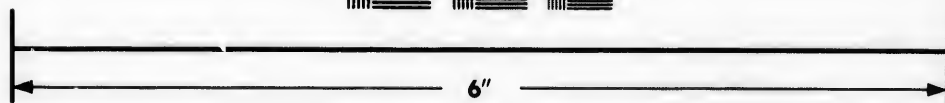
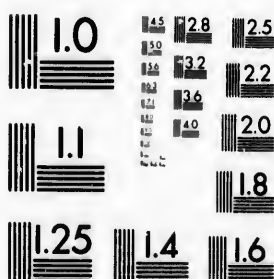


IMAGE EVALUATION TEST TARGET (MT-3)



Photographic
Sciences
Corporation

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

**CIHM
Microfiche
Series
(Monographs)**

**ICMH
Collection de
microfiches
(monographies)**



Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques

© 1992

Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

- ☐ Coloured covers/
Couverture de couleur
- ☐ Covers damaged/
Couverture endommagée
- ☐ Covers restored and/or laminated/
Couverture restaurée et/ou pelliculée
- ☐ Cover title missing/
Le titre de couverture manque
- ☐ Coloured maps/
Cartes géographiques en couleur
- ☐ Coloured ink (i.e. other than blue or black)/
Encre de couleur (i.e. autre que bleue ou noire)
- ☐ Coloured plates and/or illustrations/
Planches et/ou illustrations en couleur
- ☒ Bound with other material/
Relié avec d'autres documents
- ☒ Tight binding may cause shadows or distortion
along interior margin/
La reliure serrée peut causer de l'ombre ou de la
distorsion le long de la marge intérieure
- ☐ Blank leaves added during restoration may appear
within the text. Whenever possible, these have
been omitted from filming/
Il se peut que certaines pages blanches ajoutées
lors d'une restauration apparaissent dans le texte,
mais, lorsque cela était possible, ces pages n'ont
pas été filmées.

☐ Additional comments: /
Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X	14X	18X	22X	26X	30X
☐	☐	☐	☐	☒	☐
12X	16X	20X	24X	28X	32X

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- ☐ Coloured pages/
Pages de couleur
 - ☐ Pages damaged/
Pages endommagées
 - ☐ Pages restored and/or laminated/
Pages restaurées et/ou pelliculées
 - ☒ Pages discoloured, stained or foxed/
Pages décolorées, tachetées ou piquées
 - ☐ Pages detached/
Pages détachées
 - ☒ Showthrough/
Transparence
 - ☐ Quality of print varies/
Qualité inégale de l'impression
 - ☒ Continuous pagination/
Pagination continue
 - ☐ Includes index(es)/
Comprend un (des) index
- Title on header taken from: /
Le titre de l'en-tête provient:
- ☐ Title page of issue/
Page de titre de la livraison
 - ☐ Caption of issue/
Titre de départ de la livraison
 - ☐ Masthead/
Générique (périodiques) de la livraison

The copy filmed here has been reproduced thanks to the generosity of:

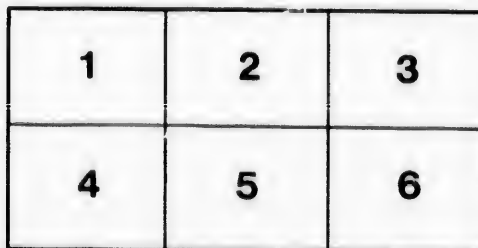
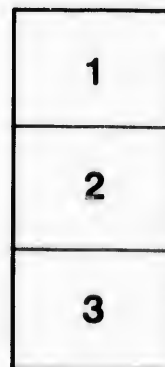
National Library of Canada

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche shall contain the symbol $\rightarrow$ (meaning "CONTINUED"), or the symbol ∇ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:



L'exemplaire filmé fut reproduit grâce à la générosité de:

Bibliothèque nationale du Canada

Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en papier est imprimée sont filmés en commençant par le premier plat et en terminant soit par la dernière page qui comporte une empreinte d'impression ou d'illustration, soit par le second plat, selon le cas. Tous les autres exemplaires originaux sont filmés en commençant par la première page qui comporte une empreinte d'impression ou d'illustration et en terminant par la dernière page qui comporte une telle empreinte.

Un des symboles suivants apparaîtra sur la dernière image de chaque microfiche, selon le cas: le symbole $\rightarrow$ signifie "A SUIVRE", le symbole ∇ signifie "FIN".

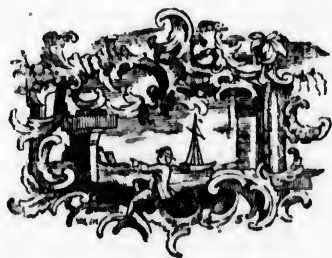
Les cartes, planches, tableaux, etc., peuvent être filmés à des taux de réduction différents. Lorsque le document est trop grand pour être reproduit en un seul cliché, il est filmé à partir de l'angle supérieur gauche, de gauche à droite, et de haut en bas, en prenant le nombre d'images nécessaire. Les diagrammes suivants illustrent la méthode.

OBSERVATIONS
ON THE
FLOATING ICE

WHICH IS FOUND
IN HIGH NORTHERN AND SOUTHERN LATITUDES.

TO WHICH ARE ADDED
EXPERIMENTS
ON THE
FREEZING OF SEA WATER.

By B. HIGGINS, M.D.



L O N D O N,
Printed for C. HEYDINGER, opposite the Theatre
Royal, Drury Lane, in Bridges-Street, STRAND.
M. DCC. LXXVI.

28
29
30

C

I

C

I

w

fr

an

ex

A

fr

th

fe

ot

th



OBSERVATIONS

ON THE

FLOATING ICE,

WHICH IS FOUND

IN HIGH NORTHERN AND SOUTHERN LATITUDES.

SINCE the return of the King's ships from voyages of discovery, both in high Northern and Southern latitudes, I have found that it hath been a disputed point, whether the ice which they have met with, was formed chiefly from the salt or fresh water. I should rather conceive that this doubt must have arisen from what is mentioned by the great Mr. BOYLE, in his experiments on heat and cold, or from an observation of M. ADANSON at the end of his voyage from Senegal, because from the quantity of ice merely, (at least to the Northward) the early navigators never conceived that it was produced from sea water.

In full proof of this, not to state the opinion of several others on the same head, I shall content myself with citing that of Sir MARTIN FROBISHER, who is well known to
S have

have made three successive voyages to Groenland, with a further intent of discovering the North West passage from Europe to the Pacific Ocean. In the second voyage of this celebrated navigator, he observes:

"We found none of these islands of ice salt in taste, whereby it appears that they were not of the Ocean water congealed, which is always salt, but of some standing or little moving lakes; the main sea freezes not, and therefore there is no *Mare Glaciale*." In his third voyage he most anxiously repeats this same opinion, and in still stronger terms, so that what he hath thus laid down, was not an occasional observation merely, but what he had much reflected upon, and found to be confirmed by his experience in those Northern Seas (a).

This opinion of Sir MARTIN FROBISHER's, seems not to have been disputed by any one, till the time of Mr. BOYLE, who observes, that there are diverse in Amsterdam, who used to thaw the ice of Sea water for brewing, and then cites BARTHOLINUS *de Nivis usu. De glacie ex aquâ marinâ, certum est si resolvatur, salsum saporem deposuisse, quod non ita pridem expertus est Clarissimus FINKIUS in glaciei frustis, ex portu nostro allatis* (b).

I shall not now criticise either what falls from Mr. BOYLE himself, or from BARTHOLINUS, though it is very clear that the ice alluded to by both, must have probably been formed from fresh water, either in the rivers or lakes which empty themselves into the Zuyder Sea, because I shall hereafter contradict the

(a) See HAKLUYT, Vol. II. p. 62, and 67.

(b) BOYLE's Works, Vol. II. p. 264. Folio.

the assertion of BARTHOLINUS, by the actual experiment, which I have tried myself during the late hard frost.

To do justice indeed to Mr. BOYLE, he afterwards upon more mature consideration, shews it to be his opinion agreeable to that of Sir MARTIN FROBISHER, that the fresh water obtained from ice floating in the Sea, proves it could not have been formed from the Ocean, "because the main Sea is seldom or ever frozen." (c)

The next Author who supposes that congealed sea water, is by this process rendered sweet to the taste, is Monf. ADANSON, who informs us, that upon his return from Senegal in 1748, he carried two bottles of Sea water taken up on the coast of Africa, from Brest to Paris, which, during an intense frost, was so frozen as to burst the bottles, and the contents afterwards became palatable. (d)

To this fact I shortly answer, either that the bottles were changed, or otherwise that Monf. ADANSON does not mention the circumstance by which the taste of the sea water was thus altered upon it's being dissolved. Mr. NARINE hath been much more accurate in stating his experiments with regard to the freezing sea water, in a Paper read before the Royal Society on the 2d of February, 1776, as he mentions that in order to clear the ice from any brine which might adhere to it, he washed it in a pail of pump water for a quarter of an hour, after which he informs the Society, that to his palate it was perfectly free from any taste of salt.

§ 2

This

(c) BOYLE's Works, Vol. II. p. 302.

(d) Voyage au Senegal, p. 190.

This is most undoubtedly the fact, but Mr. NAIRNE does not seem to be aware from what circumstance the ice thus melted had become fresh water; (*e*) and indeed I must admit, that upon the first experiment which I made with regard to freezing sea water, I deduced the same inference that he hath done, having washed it in fresh water for the same reason that he did, viz. to get rid of the brine which might adhere to the surface of the ice.

To determine therefore whence this freshness in the thawed ice might arise, I placed a large piece of what remained frozen (without being washed at all in pump water) to be dissolved before the fire, which tasted very salt as one might naturally suppose.

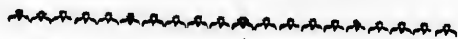
The weather continuing to be very severe, I froze more sea water, repeating the experiment of freshening it or not, by leaving it, or not leaving it in pump water, which always turned out uniformly to be the same; and the reason of which, is the following.

When Sea water is frozen, it does not form ice similar to that from fresh water, being by no means so solid or transparent as the former, as it consists of thin laminæ or plates, between which the brine is deposited, and if the ice

(*e*) As Mr. NAIRNE in his Letter to Sir JOHN PRINGLE, says that one of his great reasons for trying these experiments, was to determine whether the ice which floats in the Northern Seas is formed from the salt water or not, he therefore should have thawed the ice precisely under the same circumstances with the Sea water adhering, as the navigators take it up. The truth is that if the piece is at all large, the adhering salt water can scarcely affect the taste at all, and I have melted the central parts of a pretty large mass, which became very salt after dissolution, though entirely detached from the Sea water, in which it had been frozen.

ice is accurately examined, the small portions of brine between the plates may be easily distinguished. If this brine therefore is removed, the laminæ of ice when dissolved become sweet to the taste, but if thawed together with the brine intercepted between the laminæ, the taste is salt, nor can the ice be diverted of the brine, by merely leaving it to drain.

Having satisfied myself thus far from the freezing sea water by the natural cold, and under the common circumstances of exposing it to the air in small china cups, I applied to Dr. HIGGINS to prosecute these experiments with his more ample apparatus, and knowledge of chemistry; who was immediately so good as to suggest and try the following experiments, which will throw further light upon this subject. (f)



“ JANUARY 2d, (g) 1776. A gallon, Winchester measure, of Sea water, which I had fresh imported from Mr. OWEN, in Fleet-Street was placed in a shallow dish of Welch ware, glazed yellow; the depth of the water in this dish was three inches and a half, this shallow dish I marked A. and placed it on a brick wall eight feet high above the ground, behind my house; this wall on the Eastern side is the boundary between my premises

(f) It would be great injustice to Mr. LOMONOSOV, a Swedish chemist, not to mention that he seems to have tried experiments similar to those which I have made myself, and found the result to be as I have stated it. See *Collection Académique*, Tom. XI. p. 5. & seq. 4to. Paris, 1772. See also The Probability of reaching the North Pole discussed, p. 37, Note (y)

(g) Mr. NAIRNE began his experiments at the latter end of this month.

premises and the several gardens belonging to five or six houses in the same Street with mine; and on the Western side of it, is the area between my house and the elaboratory; and Westward of my area is the garden of Mess. WEDGWOOD and BENTLEY, which I believe is forty feet wide, bounded on the West by high buildings."

"At the same time I placed another gallon of the same Sea water in a glass body. The column of water in this vessel was about thirteen inches high, about six inches diameter at the base, and about three inches at the mouth of the vessel. I placed this body with the sea water, close by the vessel marked A. so that both were equally distant from the adjoining houses; and after marking the glass body B. I covered both vessels A and B, with glass balloons, in such manner, that the air might communicate with the surface of the water, but rain or snow might be excluded."

"A Thermometer was placed between these vessels."

"From the 2d to the 7th of January, the mercury in the Thermometer stood at various times, as low as thirty-one of Farenheit; and Thames water in shallow wooden vessels, placed on the ground, near the wall above mentioned, was often frozen to the thickness of a crown piece. But an earthen oil-jar containing twenty gallons of Thames water, and a like jar containing twenty gallons of distilled water, and each covered with a pewter dish, preserved the water contained in them, from freezing during this interval."

"About the 7th of January, the mercury in the course of twenty-four hours, did not rise above thirty-one, but sometimes sunk to thirty. Ice was formed in the vessel marked A.
but

but none in the vessel marked B. Ice was at the same time formed in the great jars containing Thames water and distilled water; and to a thickness much greater in the Thames water, than in the same water distilled. The ice obtained from the vessel A. was all formed on the surface of the water; and consisted of thin laminæ adhering to each other weakly, and intercepting in their interstices a small portion of water, which was saline to the taste. This ice beaten gently with a glass pestle to divide the laminæ, then drained, and then washed in distilled water, tasted like the ice of fresh water; and being placed in a glass funnel before a culinary fire, so that the water might drain off as soon as formed, it dissolved in half an hour, and not in less time, although the Thermometer placed at the same distance close to the funnel rose to 160; and the side of the funnel next the fire was hot to the like degree as nearly as could be ascertained by the touch. The water of the ice thus melted was fresh and palatable, and measured half a pint."

"From the 9th of January to the 11th inclusive, the mercury rose some days to forty, and during three or four hours on other days, it sunk and remained at thirty, and sometimes for an hour or less, it sunk to twenty-nine. But it did not remain at thirty during any of these days, for more than four or five hours, unless at the hours of rest, when no observation was made. During this period, a thin coat of ice, like the former, was produced on the water in the shallow vessel A. but no ice was formed in the vessel B."

"January 12, the Thermometer pointed for several hours between thirty-one at the highest, and twenty-nine at the lowest

lowest. A thick crust of ice, of the texture before described, was formed in the vessel A. This ice broken, washed, and dissolved, became fresh water, measuring a pint or more. This quantity of ice placed in a funnel, before a fire, in the circumstances already described, was not all dissolved in an hour and ten minutes. No ice was formed in the vessel B. (*h*)."

"January the 13th at night, and 14th in the morning, the Thermometer sunk for some hours below twenty-seven, and did not rise during sixteen hours above twenty-eight. The water in the vessel A, remaining after the foregoing congelations, was frozen to the thickness of a quarter of an inch in the center, and three quarters of an inch in the circumference, but no ice was formed at any greater depth in the water. This ice, like the former, was laminated, and when bruised and washed, it formed fresh water to the quantity of three pints."

"On the same day, *viz.* 14th of January, in the morning, the Thermometer pointing below twenty-seven, the Thames water in the great jar was frozen to the thickness of three or four inches, if not more, contiguous to the jar and the surface. The distilled Thames water in the other jar was frozen to the thickness of two inches, or thereabouts, and contiguous to the jar and surface of the water; and the sea water in the

(*h*) "The foregoing observations were committed to writing, on the days when they were respectively made, but the day of the month was not then accurately noted. It may therefore be found that I have placed some of the foregoing temperatures a day anterior, or posterior to the day on which they were observed."

the glass body marked B, was for the first time frozen. On the surface and in the center of this surface, the ice was half an inch thick, at the circumference it was an inch thick; and from the circumference and surface, the ice formed contiguous to the glass, in such manner, that the crust was an inch thick near the glass and surface, but as it advanced downwards towards the wider part of the glass, it tapered to an edge, terminating within an inch of the bottom of the vessel."

"Thus all the ice was formed on the surface and contiguous to the glass, and was thickest where the vessel was narrowest; that is, the quantity of ice was inversely as the diameter of the vessel. This ice resembled that obtained in the shallow vessel in its laminated structure and sponginess, and in its enveloping a portion of the salt water; with this difference only, that the laminæ shot vertically, and from the circumference inclining towards the center, not directly, but so as to form with the center an angle of about 15 degrees. This ice bruised and washed, melted to a pint and a half of pleasant fresh water. The time and heat was nearly the same as I described above."

"Mr. BARRINGTON at this and former periods observed, that the separation of the laminæ of the ice by bruising, accelerated the effect produced by washing; that is, the extrication of the intercepted brine."

"January the 19th at night, the mercury in the Thermometer sunk to twenty-six. The Sea water remaining after the foregoing congelations in the flat dish marked A, was frozen so far, that only a pint remained fluid at the
T
bottom

bottom. This ice was in all respects like the former portions. Bruised, washed and melted, as on former occasions, it gave a quart of fresh water. At the same time, the water in B. was frozen, in the manner before described, but in a larger quantity, and some laminæ of ice shot close to the glass as far as the bottom of the vessel. This ice bruised and washed as formerly, and placed before the fire in a glass funnel, melted in a heat of a hundred and sixty, in an hour and a half, to one quart of fresh water."

" January the 20th, the mercury which stood at twenty-seven, and fell to twenty-six, towards twelve o'clock, fell in a few hours to twenty-four, and before nine at night, fell to twenty-three. Only a thin coat of ice was formed on the water, in A, which I did not disturb, expecting it to freeze deeper, during the night. The water in the vessel B, was frozen to some thickness at the surface, and contiguous to the sides of the glass body, but not at the bottom. Expecting a stronger congelation, I suffered this also to stand untill the next morning, and consequently could not determine the quantity of ice formed in it, otherwise than by feeling near the surface, whereby I presumed the quantity of ice to be equal to that last obtained, and formed in the same manner."

" January the 21st in the morning, the Thermometer pointed to twenty-eight. The thin crust of ice observed on the preceding night, did not appear to be encreased or diminished in the vessel marked A. The laminæ of this ice adhered so weakly, that the whole crust could not be raised without breaking. This ice bruised and well washed, dissolved to
near

near half a pint of water brackish to the taste. And the same day, in the morning, the ice in B, was removed, bruised and washed; it melted to a pint or more of fresh water."

"From the 21st to the 26th of January, the water in the vessel marked B, was frozen twice, and the ice formed each time, was bruised and washed, and melted to fresh water, both portions measuring one pint or more."

"From the 26th of January at Sun set, to the 27th, at eleven o'clock in the morning, the mercury in the Thermometer, stood at the usual hours of observation, between twenty and eighteen. The water remaining after the foregoing congelations, in B, was frozen so far, that only half a pint remained fluid. The ice bruised, washed and dissolved, tasted a little brackish, and measured one pint and a half."

"On the 28th of January the mercury stood in the morning, and until four o'clock at noon, between twenty-two and nineteen, at before eleven o'clock, it sunk to seventeen. Very little ice was formed in the vessel B, and what was formed, very easily crumbled or fell to small flakes in attempting to take it out. I therefore suffered it to remain in the liquor until the morning."

"On the 29th of January, the mercury stood between twenty and twenty-two, until six o'clock; and between twenty and nineteen, from six until twelve at night. The quantity of ice formed on the preceding day, was not notably augmented or diminished; bruised, washed, and melted, it yielded two ounces of water brackish to the taste, in a greater degree, than any of the foregoing portions which were washed."

"On the 30th of January, finding that the temperature of the preceding evening, of the night, and of this day, which was between nineteen and twenty-one, had caused no notable congelation in the small quantity of water remaining in B. finding also that the residue of the water in A, admitted of no further congelation worth notice; and considering that the slender laminæ of ice lately formed in these waters, melted to salt water, and consequently, that no further congelation capable of separating the fresh water from the brine, even with the assistance of washing, could take place; I mixed the concentrated brine in A, with that in B, and found both scarcely measured a wine pint: some small crystals were found in the bottom of both vessels, which sunk in the brine, and were to the taste Sea salt. It is thence evident, that some Sea salt is formed crystalline, by the concentration produced by cold, gradually applied, and causing congelation: only on the surface of water, or not affecting that part of it, which is contiguous to the bottom of the vessel."

"The quantity of these crystals of Sea salt was about two grains. I poured them together with the water into a china plate, set in a sand heat, and by crystallization obtained from Sea salt, and the saline contents of Sea water, in a dry form near two ounces, averdupoise."

"Now as this quantity of Sea water, (that is two gallons), taken on our coast, generally yields about seven ounces of saline matters; it appears, that two thirds or more of the sea salt, and bitter salts of Sea water, are intercepted in the ice of the successive congelations, and are washed away by fresh water, applied as above mentioned. Hence it appeared, that

that Sea water may be freshened by freezing, provided the brine enveloped between the laminæ of this ice, is washed away. And in cold countries, salt might be prepared from Sea water at a very moderate expence, by freezing shallow ponds of this water, by turning the ice to drain off the brine, and then, when the brine is reduced to a twentieth part or less, very little evaporation and fuel will be necessary towards the formation of the salt (*i*). But all the salt of the Sea water employed, will not be obtained, because the greater part of it will be retained between the laminæ of the ice which must be removed; and the concentration, by freezing cannot be advantageously carried further than is above expressed, because at that degree of concentration, the cold and the time necessary to cause further congelation, must be very considerable, as will the waste of salt likewise; since then the ice is strongly saline."

"A small portion of the ice taken at various times from B, since the 26th of January, was not washed, but only left to drain in a funnel, and each portion thus drained during five or six days, being separately dissolved, tasted strongly of salt; although the like ice which was bruised and washed, yielded fresh water. This proves that washing removes the intercepted brine; and that this brine does not separate by draining."

"January the 20th, at eight o'clock in the evening, the Thermometer pointing at twenty-three in the open air, where the

(*i*) "WALLERIUS says, this art is practised in the Northern countries."

the Thermometer stood, I mixed snow with spirit of nitre, and placed in the mixture a glass half pint tumbler full of Sea water; and at the same time placed the Thermometer in the mixture. In two minutes, the mercury sunk out of the tube quite into the globe. The scale extends only twenty-five degrees below O. of Farenheit; wherefore I could not determine how many degrees lower it would have sunk on a more extended scale. In five minutes, some slender laminæ of ice began to shoot from the circumference of the water, and adhered to the glass. The whole water was *not frozen in less than an hour*, at which time, the mercury in the Thermometer, rose to twenty degrees below O. Having another mixture of the same kind ready made, I briskly removed the tumbler with the ice it contained into the fresh mixture, which like the former, sunk the mercury into the globe."

"The ice of Sea water is more opaque than that of fresh water, when both are naturally congealed. For, the elastic fluid in common water forms bubbles only in the central parts of the water last frozen; but the ice of sea water consists of alternate parts of ice and brine; the density of which being unequal, and the matter of them being also dissimilar, light cannot be freely transmitted, but is partly reflected and refracted, according to Sir I. NEWTON's Ideas of Vision."

"In the experiment last mentioned, the ice was uncommonly opaque; and when it was exposed to the fresh frigorific mixture, it became like a mass of snow compressed, having a snowy whiteness and opacity, perfect near the surface, but not perfect towards the bottom."

"The

"The tumbler with the ice it contained, was kept in this last mentioned mixture an hour, when the mercury denoted, that no further degree of cold could be given by this mixture. The tumbler was then placed in snow until the next day, to preserve the ice for further observation. Notwithstanding the extreme cold to which it had been so long exposed; and the cold medium in which it was placed, the ice was not solid like that of fresh water, but on the contrary could easily be cut through the center of the mass with a knife. The ice tasted equally of salt through the whole mass, in the same manner, as a like quantity of Sea water doth. Bruised briskly, washed as already described, and melted, it yielded fresh water, to the quantity of four fifths of the water frozen; wherefore in washing, very little ice was dissolved, whilst the salt water intercepted in the ice was removed."

"M. BARRINGTON having observed, that an artificial freezing, commences from the bottom and sides of the mass of water, placed as usual in the frigorific mixture; but natural freezing commences on the surface, and proceeds downwards: and it occurring to me that the specific gravity of incongealable brine, is greater than that of the congealable water; and consequently that this greater specific gravity, favours the separation of brine from the ice of Sea water, when the freezing commences on the surface of Sea water; and may be an impediment to the separation of the incongealable brine from the ice artificially formed in Sea water, when the congelation proceeds from the bottom upwards. On these considerations it seemed, that the foregoing experi-

experiments, only indicate, that ice formed in Sea water, cannot when melted become fresh water, unless it be washed in fresh water; but do not fully prove, that ice formed on the surface only, and proceeding slowly downwards, in Sea water, may not consist of fresh water, and be freed from brine, by reason of the specific gravity of brine, and other unnoticed circumstances. Therefore, on the 21st of January at two o'clock, when the mercury stood in the open air at twenty-nine, I made the following experiment, with a view to determine whether Sea water frozen artificially from the surface downwards, in the manner performed by nature, would not yield ice of a solid texture, and capable of melting to fresh water without washing, and merely by draining; which must take place in mountains of ice, if any are formed in the Northern Sea: because ice being specifically lighter than water, and the access of congealed water being at the base, the portions first frozen, will be raised above the water by succeeding portions frozen, and thus a mountain of ice may be raised, whose mass and height above water, will be to the massive base immersed in water, as the specific gravity of ice, is to that of water."

"I placed therefore a gallon of Sea water in a glazed earthen vessel, whose diameter was one third greater than the depth of the water. In this water I slung a thin glass basin cut from a bolt-head, capable of containing near two quarts of water. I slung it in this manner that it might be immersed two inches deep in the Sea water. The vessel containing the Sea water, was surrounded with snow. I then filled the basin which was suspended in the Sea water, with snow pressed down with
a glass

a glass pestle, and poured into the snow the usual quantity of strong nitrous acid."

"In fifteen minutes, some crystals of ice were formed on the interior glass basin, in the part where it was contiguous to the surface of the Sea water. In three hours, the whole bottom of the basin, containing the frigorific mixture, was coated with ice; the thickness of which was half an inch or less at the bottom of the basin, encreasing to three fourths of an inch at the part which corresponded with the surface of the water."

"I easily separated it entire from the basin, found it somewhat firmer in its aggregation than the ice slowly formed by natural freezing, and not composed of laminae like this latter; but similar in texture to the salt water frozen by artificial cold applied in the usual manner. I placed it on a heap of snow, where it remained to drain, upwards of six hours, but still was wet to the touch on the surface, and in the fresh surfaces of the fractured parts. I then placed a part of it in a glass funnel before the fire, to melt; and found the water strongly saline to the taste, but not near so saline as equal parts of Sea and river water mixed."

"Another portion of this ice, which was wrapped up in filtering paper, and left to drain on a heap of dry snow, during four days, when melted, was saline to the taste, and not sensibly different from that which had drained only six or seven hours. Whence it appeared, that ice formed in the Sea water, in circumstances similar to those which

attend natural congelation, is, nevertheless, saline to the taste."

"The several portions of water obtained in the foregoing experiments, from the washed ice of Sea water, being preserved in separate bottles, stoppered with ground glass, were next examined. Although they were fresh to the taste, it appeared by the quantity of *luna cornea*, which they all formed with saturated nitrous solution of silver, that they were strongly impregnated with marine salt, comparatively with Thames and New River water, examined in the like manner."

"Mr. BARRINGTON observing, that salt in water is an impediment to the congelation of that water, presumed, that salt in water would accelerate the thawing of ice immersed in it; and that in equal temperatures, ice would be thawed in Sea water sooner than in fresh water. I therefore made the following experiment."

"January the 20th, when the Thermometer pointed to twenty-three, about nine o'clock at night, I placed five ounces and half a drachm, averdupoise, of Thames water in a half pint glass tumbler; and the like quantity of the same water distilled, in another half pint glass tumbler of equal figure and capacity with the foregoing. The tumblers were placed on the wall formerly described, and left there covered with glass untill eleven o'clock next morning."

"In the morning, at eleven o'clock, the Thermometer pointed to twenty-eight. The water in both tumblers was frozen quite through, and formed masses of ice, transparent as crystal

crystal in every part, except the center, and near the bottom, which parts were rendered opaque to the thickness of half an inch, by a number of air bubbles locked up in the ice. The distilled water had been kept several days in the jar above described, whose mouth was only covered with an inverted pewter dish."

"Into a glass tumbler, capable of holding a Winchester pint or more, I put a wine pint of Thames water; and into another tumbler of the same figure and capacity, I poured a wine pint of Sea water concentrated, by freezing one fourth of it, the better to represent Sea water of the great oceans, which are not affected by rivers, so much as the Sea water used in these experiments, must be, as it was taken up near the North Foreland. The Sea water was thus concentrated, for these further reasons: first, that the effect of salt in the water might be more conspicuous during the thawing of the ice; and secondly, to prevent the first portions of ice thawed from diluting the salt water to a degree, which never is found in the ocean. I reduced the Sea and the Thames water contained in these tumblers to the same temperature exactly, in the open air; then taking hold of each by the summit of the glass above the water, I carried them into my study, and placed them on a carpet, fifteen feet equally distant from the fire, and three inches from the wainscot of the wall opposite the fire, and equally distant from a door on one side, and a window which extends within fourteen inches of the floor on the other. The tumblers, containing the frozen water, were immersed in a large pan of hot water, close to each other, and near the center of the pan, the water rising to the height of the ice in

U 2

the

the tumblers; after a few minutes the ice was thrown out, by inverting the glasses on clean paper. The two pieces of ice were equal in size, figure, and weight; the weight of each being five ounces averdupoise."

"The moment before the ice was taken out of the tumblers, I found the temperature of the Sea and fresh water placed as above mentioned, to be equal, and exactly thirty-four; the temperature of the air in that part of the room being forty-six. I plunged the pieces of ice immediately, one in the Sea water, the other in the fresh water. It was at this instant two o'clock, in the afternoon. In ten minutes the temperature of the Sea water was thirty-two, that of the fresh water was thirty-three and a half. In half an hour the Sea water raised the mercury to thirty-three, the fresh water raised it to thirty-four and a half."

"At this instant, viz. half an hour past two o'clock, I took both the pieces of ice at the same time, weighed them briskly, and replaced them in their respective vessels at the same instant. Of the ice placed in the Sea water, half an ounce was dissolved: of the ice placed in the fresh water, only four drachms and a half were dissolved."

"From half an hour past two o'clock, until six, I frequently changed the position of the tumblers, making one take the place of the other. At six, the temperature of the Sea water was thirty-six, that of the fresh water was thirty-seven and a half. In the manner already mentioned, the ice was at this time weighed, and replaced. Of the ice in Sea water three ounces and four drachms were dissolved; of that in fresh water, only two ounces and eight drachms."

"It

"It is observable, that the Sea water was a degree and a half colder, ever since the immersion of the ice, than the fresh water, acted on by the like mass of ice, and placed in the like circumstances; and nevertheless the ice was dissolved much quicker in the colder Sea water. The quicker solution of the ice in Sea water, was evidently the cause of the greater degree of cold preserved in it during four hours; and it already appeared, that salt water is a more powerful solvent of ice than fresh water in the like temperature. And agreeable to Mr. BARRINGTON's suggestion, the matter which impedes the congelation of water must of course facilitate the thawing of ice. The nitrous acid furnishes us with another striking instance to this effect; for no cold can be produced to freeze the water in it, and a red hot ladle cannot thaw ice placed in it, so quickly as ice is thawed by nitrous acid."

"At ten o'clock, or in eight hours after the pieces of ice were first placed in the Sea and Thames water, the temperature of the Sea water was thirty-nine, that of the Thames water only thirty-eight. At this time, of the ice in Sea water four ounces eight drachms were dissolved; of the ice in Thames water, four ounces only were dissolved. The Sea water being at this period warmer than the Thames water, corresponds with the small portion of ice remaining in it, compared with that remaining in the fresh water. The temperature of the room in the place where the tumblers stood, being, by reason of the fire kept constantly in it, forty-four, or forty-five, for the last six hours."

"In twelve hours, or at two o'clock in the morning, the temperature of the room near the vessels of water, being
nearly

nearly the same as formerly described; the temperature of the Sea water was forty; the temperature of the fresh water was thirty-nine. Four ounces fifteen drachms of the ice in salt water, were dissolved, only one drachm remaining; four ounces ten drachms of the ice in fresh water were dissolved, only six drachms remaining."

"At the end of the thirteenth hour after the immersion of the masses of ice in the fresh and in the salt water; that is, at three in the morning, the temperature of the room was forty-five, near the place where the tumblers stood. The temperature of the open air was thirty-one. The ice in the Sea water was melted. The quantity of ice remaining in the fresh water was one drachm, which in fifteen minutes more was entirely melted."

"At this period, when the ice in the fresh water was melted; that is, a quarter of an hour past three, the mercury stood at forty in the fresh water; in the salt water it stood at forty-one. In a quarter of an hour after this, the mercury stood at forty-two in the salt water, and at forty-one in the fresh water. In a quarter of an hour more, the temperature remained unaltered in the salt and fresh water, although the temperature of the air between, and near the vessels was forty-five, and the vessel on the right was placed on the left, and replaced several times. And both vessels were at all times equidistant from the wainscot, which was perfectly close, as were the boards of the floor also."

"In a quarter of an hour more the temperature of the air near, and between the tumblers, remained forty-five: the
tempera-

temperature of the fresh water was scarcely forty-two: the temperature of the salt water was forty-two and a half."

"In a quarter of an hour more the temperature of the air between the tumblers being forty-four and a half, the temperature of the salt water was forty-three; the temperature of the fresh water was somewhat more than forty-two. It was now past four o'clock in the morning on Monday the 22d of January. I went to bed, leaving the tumblers in the position described."

"It was observed, during the foregoing and other experiments, and it is visible from the experiments related, that fire in diffusing itself from warm bodies to contiguous cold bodies, proceeds slowly; that cold bodies do not acquire the temperature of the warmer medium in which they are immersed, so soon as is commonly imagined; but on the contrary, require a considerable time for that purpose; and this time is directly as the diameter of the cold body."

"It was also observed and inferred from these experiments, that a temperate body, like water, placed in a cold medium, as in air, cooled to thirty or thirty-one of Fahrenheit, requires many hours before it acquires the temperature of the surrounding medium, and before a congelation commences; and that the time necessary for the commencement of the congelation is directly as the mass and shortest diameter of the water, and the progress of the congelation is universally as the depth of the water."

"It may be also observed, that of a given mass of water, as much was frozen in five hours, in a temperature of twelve degrees below the freezing point, as was frozen in one hour

hour in a temperature fifty degrees below the freezing point. And that long duration of the temperature between twenty and thirty-two, is towards the congelation of water, equivalent to intensity of cold, (such as is marked O. and below O. in Farenheit) but of short duration."

"It may be likewise observed, that water in thick jars covered was not frozen, when water in open vessels was frozen; and that water included in massive vessels of wood, or surrounded by any matter, except water, to some thickness, preserved its temperature, and resisted congelation, longer than the like quantity of water exposed to the cold air; and that water in thick vessels was not frozen so soon as a like quantity of water in thin vessels of like matter, figure, and capacity; and it may be thence inferred, that fire doth not so quickly pervade thick bodies, as it does thin bodies; and that fire pervades water more freely than it does any other body, and sooner diffuses itself from water to air, than it doth diffuse itself from any other body to air."

"Thence it followed, that in reasoning on the phenomena of congelation, the masses of water, the duration of cold temperature in the atmosphere, and the masses of other matter surrounding water, are to be considered. Deep rivers, and lakes, do not freeze so soon as shallow rivers and lakes. Large bodies of water are never frozen in any temperature of short duration; but shallow waters are often frozen in the summer."

"It need not be presumed, that certain lakes which are never frozen, communicate with subterranean fires, or hot mineral streams; or that they are impregnated with matter which im-

pedes

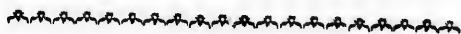
impedes congelation; but rather it is to be presumed, that as fire slowly pervades, enters or quits bodies, the time necessary for its diffusing itself from deep lakes to the cold atmosphere, is greater than ever such temperature of the atmosphere, continues without intermission below the freezing point."

"By the like reasoning applied to masses of earth, and other matter, which are not so quickly pervaded by fire as water is, we can conceive why deep wells, and springs at or near their issuing from the earth, are never frozen in this climate, even when navigable rivers are ice bound. We also understand why the main pipes, buried in our streets, retain the water fluid, when the pipes leading from these to the houses, and crossing the area of each house, are choaked with ice; and why hay bands twisted round these small pipes, prevent the freezing, &c. &c."

"On these grounds it is presumed, that no considerable congelation ever takes place in the Sea, because this is the greatest and deepest mass of water we know of; and because it is always in motion, and communicates with the water of temperate climates; because Sea water is not so easily frozen as fresh water; because the ice found in the Sea is solid, and in transparency not different from the ice of fresh water; and lastly, because this floating ice which is met with by navigators, both in high northern and southern latitudes, when melted is palatable to the taste; whereas the ice formed from Sea water is very saline, if it is thawed, without having been freshened by being placed in pump water."

"It is also presumed, that in the deep Northern Seas, the water near the surface will be found warmer than that near

the bottom, at the approach of summer; and will be found colder near the surface than at the bottom, in the first month of the cold season, for the reasons already expressed. And in like manner, that during the first six or eight hours of any freezing in England, the water in any deep lake will be found colder near the surface, than the water near the bottom; but that the water near the bottom will be found colder than the water near the surface, in twenty-four hours after a perfect thaw, provided the air be temperate, or nearly so."



IT having been proved from what hath been already urged, as well as by the preceding experiments, that the floating ice which is observed both in high southern and northern latitudes, cannot be probably formed from Sea water, it may be thought incumbent upon me to shew how such quantities can be supplied from springs, rain, or frozen snow.

The rivers which are always found at certain intervals in any large tract of land, undoubtedly supply considerable part of such ice; but there are not wanting other sources from which these floating masses may be produced.

The larger and higher ice islands, I conceive to be chiefly what are called *Ice-bergs*, undermined by the rills, and melted snow, during the summer, of which we have an accurate account in the late voyage towards the North Pole (k).

Others

(k) " Large pieces frequently break off from the Ice-bergs, and fall with great noise into the water: we observed one piece which had floated out
" into

Others, which happen to have projected over the sea may have had their foundations so fapped by the waves during
X 2 a storm,

" into the bay, and grounded in twenty-four fathoms; it was fifty feet high
" above the surface of the water, and of the same beautiful colour as the
" ice-berg," p. 70.

I have likewise been favoured with the following account of the formation of ice islands on the coast of Labradore, from Lieutenant John Cartwright, of the Royal Navy, to whom I have not only this obligation. [See the Probability of reaching the North Pole, p. 5.]

DEAR SIR,

Thursday, Feb. 28, 1776.

In conformity with my promise of yesterday, I now send you, as near as I can recollect, my brother's account (who hath resided four years on the Labradore coast) of the formation of those great masses of frozen snow, seen annually in very great numbers on the northern coasts of America, and by mariners usually called *Islands of Ice*.

Along the coast of Labradore, the sea, in winter, is frozen to a great distance from the land, [how this ice is produced, will appear p. 145.] The north west is the prevailing and coldest wind. The snow, carried by this or any other westerly wind over the cliffs of the coast, falls becalmed upon the ice at the foot of the said cliffs, drifting up to the very tops of them, although many of them are not inferior to that of Dover or those about Lulworth. The current of the strong western winds, having passed these precipices, takes its course downwards into the undisturbed air below; but it is not until it arrives at some distance from the land, that it can be felt on the surface of the sea. Having the frozen surface of the sea for a base, the precipice for a perpendicular, an hypethenuse is made by the descending direction of the wind. The inclosed triangle, be the cliffs ever so high, will be filled with snow; because the tops of the adjoining hills being quite naked, are entirely swept clear of snow by the violence of the storms, and what would otherwise have lain there, is carried to the leeward of the hills, and under the shelter of the cliffs, where it is deposited in infinitely
greater

a storm (*l*), as to have lost their support, whilst others again may have been reft from the mafs to which they before adhered, by the expanfive power of the froft (*m*). Great

greater quantities than it would fall without fuch a caufe. The hypothenufe of fuch triangle is frequently of fuch a flope as that a man may walk up or down without difficulty. By frequent thaws, and the occasional fall of moi- fture interrupting the froft, during the firft parts of the winter, the fnow will, in fome fmall degree, difsolve, by which means it only acquires a greater hardnefs when the froft returns; and during the courfe of that rigorous fea- fon it generally becomes a very compact body of fnow-ice. In the fpring of the year, the icy bafe gives way, and its burden plunges into the fea, fometimes entire, fometimes in many fragments. As the depth of water in many parts is forty, fifty, one hundred fathoms, and upwards, clofe to the fhore, thefe bodies of ice, vaft as is their bulk, will frequently float without any diminution of their contents, although the very large ones do often take the ground, and fometimes are not fufficiently reduced by either the penetra- tion of the fea and the rain water, or of a whole fummer's fun to get at li- berty again before another winter.

The above relation which my brother gives from his own Obfervation, in North Latitude, 52 deg. 15 min. accounts very naturally and eafily for the for- mation of that furprizing number of the vaft pieces of ice which is annually feen on the Labradore coaft, and confiderably to the Southward.

JOHN CARTWRIGHT.

(*l*) " The fea has wafhed underneath the ice cliffs, as high as the Kentifh " Forelands, and the arches overhanging, fupport mountains of fnow, which " have lain fince the creation." WOOD'S *Voyage*, p. 20.

" Cuncta gelu, canaque æternum grandine tecta,
" Atque ævi glaciem cohibent, riget ardua montis
" Ætherii facies, furgentique obvia Phœbo,
" Duratas nefcit flammis mollire pruinas."

SILVS ITALICUS, Lib. III. l. 480.

(*m*) " The rocks along the coaft burft with a report equal to that ofartil-
" lery, and the fplinters are thrown to an amazing diftance." MR. WALE in
Philofophical Transactions, Vol. LX. p. 125.

Great part of the field, or lower ice, I take to be formed by the snow falling on the sands left bare for six hours, (from half ebb to half flood) which immediately dissolves upon touching the sand, and before the tide returns, becomes solid ice; part of these pieces are by the wind, or tide, again returned to the same sands, where they again meet with another store of ice, formed during another six hours, which, in the course of a winter, must, by packing, accumulate to immense masses. That this is not mere conjecture, but the fact, I appeal to Capt. JAMES's account of what he himself was witness of whilst he wintered at Charlton Island, in Hudson's Bay.

Now if we examine a globe, we shall find, that from north latitude sixty to seventy degrees, more than half its circumference is land, which is open to a Northern Sea, from which large tract of coast much greater quantities of floating ice may be derived, than have ever been met with by navigators, without being obliged to suppose that any part of it is formed from Sea water.

But it may be said, that our late enterprising navigators to the southward, have also met with as great a quantity of ice in the opposite hemisphere, without scarcely discovering any land.

To this I answer, that their circumnavigation was, at a medium, about fifty-five degrees south latitude, though they made pushes greatly to the southward in three points, and in one of these to seventy-one degrees ten minutes. In the other instances as far as 67 deg. and 67 deg. 30 min. at least, as I have been informed.

There

There is consequently a very large space in which there may be many a frozen region, which they have not had any opportunity of discovering. If, for example, a navigator from the southern, was sent upon discoveries to the northern hemisphere; and Europe, as well as Asia and North America having been sunk by earthquakes, was to report that he had circumnavigated at fifty-five degrees north latitude, at a medium; made pushes even to seventy-one degrees in different directions, without seeing any continent, and that therefore there was no land to the north of fifty-five degrees, his countrymen would be much deceived by such report; because Denmark, Norway, Sweden, Muscovy, Tartarian Asia, and part of North America continued in their present situation.

Besides, however, the ice which may come from *Tierra del Fuego*, Captain Cook hath discovered two frozen islands between Cape Horne, and that of Good Hope, which were covered with ice and snow (*n*). The first of these situated in fifty-four degrees, is called, *Georgia Australis*, and the second in fifty-nine degrees, *Thule Australis*, which appeared so large, to some eyes, at least, that it was conceived to be part of a continent.

It is believed also that no ship hath been beyond forty-eight degrees to the southward of New Zealand, and from the coldness of the most southern of these large islands, I cannot but suspect that there is a considerable tract of land between it and the Pole.

Having

(*n*) Hence, whatever land is discovered to the south of this latitude, must produce ice. There is also a large tract of land named in some maps, the *Gulph of St. Sebastian*, which is not far distant from *Georgia Australis*, and which possibly may have escaped Captain Cook.

Having thus endeavoured to account how all the floating ice which is met with may be supposed to be formed from fresh water, I cannot but risk another conjecture that the time of the year at which attempts are commonly made to penetrate both to high northern and southern latitudes, (though favourable in many other circumstances) (*o*) is probably the season when it is most probable the greatest quantity of floating ice will be seen.

This seems to follow as a necessary consequence from the push being never made before Midsummer, and often a month later, which is precisely the time when the ice begins to break up in the fresh water rivers, &c.

I have accordingly minuted down from several voyages into high northern latitudes, the day on which navigators first mention seeing the floating ice.

The result of which is as follows :

Sir MARTIN FROBISHER on the 23d of June. *Hackluyt*, Vol. II. p. 77.

DAVIS in his first voyage, July 19th.—In his third, July 2d. *Ibid.* p. 99.

PET and JACKMAN on the 13th of July. *Ibid.* p. 447.

BURROW, on the 21st of July. *Ibid.* p. 277.

Governor ELLIS, July 5th. *Voyage to discover the North West Passage*, p. 127.

“ The shores of Hudson’s Bay have many inlets or friths, which are full of ice and snow, and frozen to the ground.

“ These

(*o*) *Viz.* The nights being shorter, and the rigging not being so subject to be frozen.

"These are broke loose, and launched into the sea by land floods, during the months of June, July, and August." *Ibid.*

"The first floating ice which is observed on the coast of Labradore is a joyful presage to the inhabitants of the approach of summer." Lieutenant CURTIS, in *Philosophical Transactions*.

"The ice begins to break up the 18th of June." *Danish Account of Groenland.——Voyages au Nord*, Vol. I. p. 167.

"The lakes of Lapland continue frozen on June the 24th." *Linschoten's Voyage*, *ibid.* Vol. IV.

"On the 5th of July, the Sea on two sides is observed to be covered with ice." *Ibid.* p. 187.

WOOD sees the first ice in north latitude seventy-five degrees fifty-nine minutes on June 22d.

On the 17th of August vast pieces of floating ice. *Ibid.*

"In the month of August the French observe, on the Labradore coast, mountains of ice as high as the ships." *Boyle's Works*, Vol. II. p. 303.

"On June 16th, a river in Hudson's Bay breaks up." Mr. WALES, in *Philosophical Transactions*, Vol. LX. p. 126.

"The mouth of the Lena is not open till the middle of August." *Observations géographiques, par Mr. ENGEL*. p. 229.

With regard to the ice which may be observed in southern latitudes, I shall only take notice that Sir FRANCIS DRAKE, FEUILLEE, and CLIPPERTON passed Cape Horn, or the Straits of Magellan, during the month of December, with-

out

out mentioning ice (*p*), from which it should seem that it breaks up chiefly during the months of January, February, and March, answering to our July, August, and September (*q*).

Three Dutch ships which sailed on discoveries, with Commodore Roggewein, in 1721, met with much ice to the south of Cape Horn in the middle of January. The Author of the Narrative afterwards makes this observation: "These mountains of ice, which are seen in the latitude of Cape Horn, prove that there is land towards the southern pole, it being certain that this ice cannot be formed in the ocean, though the cold is so severe (*r*)."

But it may, perhaps, be said, that the ice which breaks up in June, July, and August, or during the correspondent months in the opposite hemisphere, may remain floating for years without being much dissolved.

To this I will not take upon myself to say that some such islands when very large, may not continue more than a year, but I should conceive this not to be very common. Storms and other accidents must probably break them into small masses which

(*p*) See CALLANDER's Voyages under these three articles.

(*q*) It may possibly break up in some years earlier, perhaps in December; but some time must be allowed for its floating to the north, as far as the latitude of *Tierra del Fuego*. From the instances cited, it appears that the earliest floating ice which is seen in the northern hemisphere is not observed sooner than the 16th of June, whilst in much the greater part mention is not made of it till July.

(*r*) Histoire de l'Expedition de trois Vaisseaux, &c. *Hague*, 1739, p. 81.

which will quickly be thawed; not only because it appears, that ice dissolves sooner in Sea water, from Dr. HIGGINS's experiments; but that able Geographer and promoter of discoveries, Mr. Bailiff ENGEL, observes, that if a piece of ice is fastened by a cord and let down into the sea, it is presently melted (*s*).

Mr. WALES also informs us that he conceives most of these islands of ice are soon wasted, in the following words: "The truth is, their motion and dissolution are apparently so very quick, that I am of opinion it must be a pretty large island which is not dissolved in one summer (*t*)."

How soon likewise does the ice disappear, which is discharged from our own rivers into the sea, after our most intense frosts?

I have omitted stating the degree of cold at which the Sea water I exposed to the air begun to be frozen, and cannot now recover the memorandum which I made at the time. I am pretty confident, however, that the mercury had sunk only to twenty-seven.

But though congelation thus took place at five degrees below the freezing point, it is proper that I should state some other circumstances attending the experiment.

The Sea water which I used came from the north Foreland, which is at the mouth of the Thames, and consequently not being the same with that of the ocean, was more easily frozen.

Besides

(*s*) See *Observations Geographiques*, p. 224.

(*t*) *Philosophical Transactions*, Vol. LX. p. 112.

Besides this, the quantity was so small as not to cover a china basin deeper than an inch, both which particulars contribute greatly to the more speedy formation of ice: it need scarcely be mentioned also, that the liquid to be frozen was in a quiescent state.

How much a considerable degree of motion impedes congelation may be inferred from what may be observed in every river; for as high as the tide has any force, I doubt much whether any ice is scarcely ever formed in the fair open channel, during our most intense frosts. I attended to the Thames, in this respect, during the late severity of the weather, and it seemed to me that all the ice floated down from the upper parts of the river; but packing afterwards between the lighters, occasioned the formation of very large masses.

I have little doubt from these circumstances, that the open sea, if to be frozen at all, must require a much more intense cold than twenty-seven; but allowing any greater degree of cold in the higher latitudes, it seems deducible from the experiments of Dr. HIGGINS, that Sea water cannot be frozen into a solid state, if compared with that of ice formed from the water of rivers; nor will such ice when melted become palatable, unless it hath been previously washed in fresh water.

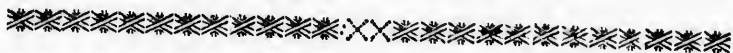
Hence it seems to be almost demonstration that the floating ice met with by navigators being both solid, and sweet to the taste after dissolution, cannot be produced from the water of the ocean.

I will venture also to insist, that if such ice was actually frozen from the ocean, it must very quickly be melted, because

cause as it must consist of detached laminæ intercepting the brine, the sea would soon intinuate itself between the interstices, so as to cause its dissolution. If any ice, therefore, should be formed in those parts of bays which are landlocked, have little or no tide, and receive considerable quantities of fresh water, when such ice is wafted fairly out to sea, I should conceive that it must disappear in a very short time.

DAINES BARRINGTON.

POST-



P O S T S C R I P T.

I TAKE this opportunity of laying before the Public the following letter from Captain MARSHALL, master of a Greenland ship, to Lieutenant HEATH, of the 41st Regiment, who formerly made a voyage or two to Spitzbergen.

S I R,

IN compliance with your request of Wednesday last, I acquaint you, that six years ago I was as high as eighty-two degrees, thirty minutes, north latitude, by observation, which is the highest I have ever been in; at that time I was mate of the Royal Exchange Greenlandman, of Newcastle. I do not know of any one who has been in a higher degree; but it has been reported at Newcastle (with what truth I cannot say) that Captain Greenshaw, of London, had told his friends, that he had been as high north as eighty-four degrees.

The Dutch, I have been informed, have penetrated to eighty-three degrees, thirty minutes; but I have it only by hear-say.

In respect to your second query, I remember, that about five years since, when I was master of the above-mentioned ship, I was in eighty-one degrees, north latitude, by observation, when there was a clear sea to the northward, as far

as the eye could reach from the mast-head; and I could not help observing to my people, that if it had happened that we were then upon discovery, we might have had a fine run to the north, as the wind blew fresh at South. The like clear sea I have observed several times during the time I have been in the Greenland service, which is now about twenty-one years. I have no doubt but that a navigator might penetrate into a higher latitude than I have been in, provided he was well acquainted with the currents, and the ice, for much depends thereon; and took the advantage of a favourable season. I have remarked, that when the frost has been severe in England, and to the southward, there has been a great deal less ice to the northward, the ensuing summer than usual; and the weather has been remarkably fine in Greenland. I have, for this reason, great expectations that the approaching season will produce a successful fishery, and that it will also afford an opportunity for a trial to reach the pole (*t*),

But the greatest difficulty attending a navigator in very high latitudes is how to get back again, for should he be beset there in the ice, his situation would be very dangerous; for he might be detained a long time, if not
for

(*t*) I am sorry to have been informed, since the Bill for promoting discoveries passed, that the attempts to penetrate to the northward will not be so frequent as I had flattered myself; because most of the Greenland vessels being insured, if any accident should happen to a ship which is not prosecuting the whale fishery, the owners will not be entitled to recover.

D. B.

for the whole winter. I speak this from experience, for I was once beset for three months, and was given up for lost, and with difficulty got out.

Any further information in respect to the land, the currents, ice, or other particulars, you may wish to have, I shall very readily communicate it, and am,

S I R,

*No. 5, Spring-street,
Shadwell, Feb. 25, 1776.*

Your veryhumble Servant,

JAMES MARSHALL.

BOOKS PRINTED FOR C. HEYDINGER,

BOOKSELLER, No. 6, opposite the Theatre Royal Drury Lane,
in Bridges Street, Strand.

1. **T**HE Probability of reaching the North Pole, discussed; containing Instances of Navigators who have reached high Northern Latitudes, and other Papers laid before the Royal Society, by the Hon. DAINES BARRINGTON, F. R. S. To which are added: Thoughts on the Probability, Expediency and Utility, of discovering a Passage by the North Pole, by a GENTLEMAN, Quarto, 2s. 6d.
2. A Supplement to the Probability of reaching the North Pole, containing Instances of Dutch Navigators who have reached high Northern Latitudes, Quarto, 6d.
3. A Second Supplement to the Probability of reaching the North Pole, containing Observations on the floating Ice, which is found in high Northern and Southern Latitudes. By the Hon. DAINES BARRINGTON, F. R. S. To which are added: Experiments on the freezing of Sea Water, by B. HIGGINS, M. D. Quarto, 1s.
4. An Account of the New Northern Archipelago, lately discovered by the Russians in the Seas of Kamtschatka and Anadir. By Mr. J. von STÄHLIN, F. R. S. To which is added: A Narrative of the Adventures of four Russian Sailors, who were cast away on the desert Island of East-Spitzbergen, together with a Description of that Island, and some Observations on its Productions. By Mr. P. L. LEROY. Translated from the German Originals, at the Desire of several Members of the Royal Society. *With an accurate Map of the new discovered Islands*, Octavo, 2s 6d. *sewed*.
5. The Elements of German Grammar. By the Rev. Mr. WENDERBORN. Dedicated, by Permission, to His Royal Highness the Prince of Wales, Twelves, 2s 6d. *bound*.
6. ——— The same Book, Octavo, 3s 6d *bound*.
7. The Authenticity of the first and second Chapters of St. Matthew's Gospel, vindicated, Octavo, 6d. *sewed*.
8. The History of AGATHON. By Mr. C. M. WIELAND. Translated from the German Original, with a Preface by the Translator, 4 Volumes Twelves, 12s. *bound*.
9. Observations on various Subjects.—I. On the Seven-times Seventy Years of Daniel, *Ch. IX. 24—27*.—II. On the Canon of the Old Testament.—III. On the true reading of the Passage, *1 Tim. iii. 16*. By JOHN CASPAR VELTHUSEN, *One of his Majesty's German Chaplains*, Octavo, 2s 6d *sewed*.
10. Reason triumphant over Fancy; exemplified in the singular Adventures of Don SYLVIO de ROSALVA. A History in which every marvellous Event occurs naturally. Translated from the German of Mr. WIELAND, 3 vols. Twelves, 7s 6d *sewed*, or 9s *bound*.
11. USONG, an Oriental History, by Baron ALB. von HALLER. Translated from the German Original, 3s *sewed*, or 3s 6d *bound*.

E R,

Lane,

23VI

aining

itudes,

AINES

robabi-

n Pole,

aining

itudes,

, con-

rthern

R. S.

r, by

by the

HLIN,

f four

tzber-

ons on

erman

With

ORN.

Vales,

Gof-

lated

umes

Years

it.—

PAR

rued.

es of

vent

vols.

lated

